8. CONCLUSIONS AND DATA GAPS

8.1. Conclusions

King County, USGS, Ecology, local universities and municipalities, and other agencies and organizations have been collecting water quality information for many years on a number of streams in King County. Results have varied widely, but many contaminants, especially organics and metals, are consistently detected in urban/suburban storm runoff (e.g. Galvin 1982, Davis 1993, Davis 1996, Davis 1998, Davis 2000, Voss et al. 1999, Voss and Embrey, 2000). While many of these studies have evaluated in-stream concentrations of these contaminants, few have assessed in-stream toxicity to aquatic organisms. This investigation was designed to evaluate the potential effect of these chemicals on aquatic organisms.

As previously discussed in the Introduction, this study was designed to answer specific questions regarding in-stream toxicity and toxicant concentrations. The specific questions, along with the corresponding conclusions, are provided below:

- **Is toxicity observed in small streams?** Yes. In-stream toxicity was observed in urban/suburban streams, but not in the reference stream.

- **If toxicity is observed, is it observed during different times of the year and during different hydrologic conditions?** Yes. Toxicity was observed during storm events in spring and fall; however, no toxicity was observed during a late fall storm event following several other storms occurring earlier in the season. In addition, toxicity was also observed in Juanita Creek samples taken during summer baseflow conditions. Previously it has been assumed that toxicant(s) in storm runoff could cause observable toxicity, but that toxicant concentrations would quickly dissipate once the storm event ended and runoff was no longer entering the stream. Therefore, storm related toxicity would be short-lived and have minimal impact on the long-term viability of the in-stream ecological community. However, toxicity observed in summer base flows suggests toxicity in Juanita Creek is not strictly storm related, it may be present on an ongoing basis, and the overall effects to the aquatic community are unknown and warrant further investigation.

- **If toxicity is observed, to what extent can it be linked to pesticides or other toxicants?** Of the 40 water samples collected from the study streams for toxicity assessment, 10 inhibited growth or reproduction of the test species relative to the reference samples. Furthermore, some pesticides and metals were detected at levels that may cause toxicity, and therefore warrant further investigation. The cause of the observed toxicity, however, is largely uncertain. Uncertainty is discussed in greater detail below. Further study would be required to determine the cause of observed toxicity.

8.2. Data Gaps

Several key data gaps have been identified that contribute to uncertainty in this assessment, including: incomplete characterization of contaminants, potential toxicity of other chemicals not measured, potential chemical interactions, lack of bioavailability information, incomplete toxicological information, toxicological relevance of analytical detection limits, and the ecological relevance of toxicity observed in the laboratory. These issues are described in more detail below.

<u>Incomplete characterization of contaminants:</u> The distribution of the chemical concentrations in the streams is incomplete. For example, it is unknown if the highest contaminant concentrations have been captured in the samples collected for this study. Conversely, the highest measured concentrations for some chemicals might be outliers, but more data would be needed to make this determination.

<u>Potential toxicity of other chemicals not measured:</u> There may be contaminants other than pesticides, metals, and BNA organics present in the streams at high enough concentrations to cause toxicity. For example, little is known about the presence, concentration, and effect of surfactants and other additives, the so-called "inert" ingredients typically present in most pesticide formulations.

<u>Potential chemical interactions:</u> Although many of the individual chemicals did not exceed effects thresholds, the potential additive, synergistic, and antagonistic effects of these chemicals is unknown. For example, additives to pesticide formulations typically act to render the active ingredient more toxic. Toxicity studies found in the published literature, such as those used in this study to develop effects thresholds, are generally conducted on active ingredients only. It is possible that chemical formulations in use are more toxic to non-target organisms than the active ingredients alone, rendering the effects threshold under-predictive of toxicity. This may be especially important when toxicity is observed but HQs are less than 1.0, as was observed in this study. Unfortunately, information on the "inert" portion of pesticide formulations can be difficult to obtain, as most chemical manufacturing companies consider it proprietary information. During this study, no attempt was made to compare combinations of detected pesticides to threshold values because no suitable published method was found.

<u>Lack of bioavailability information:</u> Pesticide additives are also designed to alter the physical properties of active ingredients, such as adherence to soil or solids. It is possible that although the active ingredients in most pesticide formulations may have low adsorption coefficients, the pesticide additives could alter the active ingredient to adsorb to solids much more strongly than published values would predict. This could also have an effect on chemical bioavailability.

<u>Incomplete toxicological information:</u> Although conservative assumptions were used to develop the effects thresholds, the lack of chronic toxicity data for some compounds, and the lack of any toxicological data for desethylatrazine, results in uncertainty. Furthermore, it is unknown if the methodologies for determining toxicity in the streams used the most sensitive species and/or endpoints for the contaminants.

<u>Toxicological relevance of analytical detection limits:</u> The toxicological relevance of the analytical detection limits for non-detected chemicals relative to appropriate effects

thresholds for aquatic life has not been evaluated for most chemicals. Exceptions include any metals or BNA organics that were detected at least once, but not in every sample. However, many of the chemicals analyzed in this study were never detected in any of the samples collected. Further study would be required to determine if chemicals that were analyzed but never detected could be present at concentrations that could cause an adverse effect. Furthermore, pesticide sales data showed glyphosate was one of the most heavily used herbicides in the King County area (Voss et al. 1999); however, no glyphosate was detected in any sample. The detection limit for this analyte was 5.0 µg/L, which is two orders of magnitude higher than detection limits for other pesticides analyzed for this study. The ability to detect glyphosate at lower concentrations would help determine if this popular herbicide is contributing to the observed toxicity.

<u>Ecological relevance:</u> The ecological relevance of the toxicity observed in the laboratory is unknown. Furthermore, comparisons of the highest measured contaminant concentrations with the lowest acceptable effects threshold identified in the AQUIRE database is a conservative approach, and does not necessarily indicate effects to the aquatic community. Information is available from other studies and monitoring programs on the benthic macroinvertebrate community, habitat availability/condition, and the occurrence of fish species in the study streams. Using a risk-based approach, this information could be used in conjunction with toxicity and chemical data to better understand the potential risks from the detected chemicals to the aquatic community.